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Retention of Cast Head Capsules by Some Nolid Immatures in Four Old World Countries

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Abstract. Certain unique features of the developmental stages of the Australian nolid *Uraba lugens* are described and illustrated, including the retention of cast head capsules by each succeeding larval instar. In many individuals this stack remains intact through pupation where several capsules remained to decorate the cocoon. Earlier observations of the same phenomemon are cited, including *Rhynchopala argentalis* in India, *Roeselia togatulalis* and *R. nitida* in Europe, and *Mimerastria mandshuriana* in Japan. These five cases in four distinct areas of the Old World, are the only so far observed amongst the nolid moths.

Uraba lugens Walker (1863), the AUSTRALIAN nolid moth illustrated here, has been variously referred to *Coesa, Mosoda, Nola, Roeselia, Sorocostia, Toxoloma,* and *Uraba.* D. S. Fletcher of the British Museum (Nat. Hist.) has informed me (in litt. - 1972) that it is probably best placed in *Uraba*; that *lugens* is the type species of *Uraba,* that a synonym of *U. lugens* is *Coesa viduella* Walk. (with the Tasmanian type specimens of both in the B.M.), and that *Roeselia* is a generic synonym of *Nola,* to which latter genus *lugens* is certainly not referrable. Its common name is the gum-leaf skeletonizer moth (Campbell, 1962).

In most years this moth is extremely abundant in the vicinity of Blackwood, South Australia (a southern suburb of Adelaide), in the foothills of the Mt. Lofty Range at about 900 feet elevation. The larvae skeletonize, and sometimes nearly defoliate, various *Eucalyptus* spp. (gum trees — MYRTACEAE) in many localities across southern and eastern Australia. They are highly gregarious in the early instars, feeding closely side by side, but gradually become semi-gregarious to more-or-less solitary as they mature. There are eleven instars according to Campbell (1962). The larvae rest exposed on, or near, the areas of feeding and are easily discovered by searching. They are able to cling with great tenacity to the flat surfaces of the smooth eucalypt leaves, with no need for silken mats or other aids to attachment, although a slight silk mat is woven for anchorage prior to moults. The major foodplant at Blackwood is *E. odorata* Behr ex Schldl. (peppermint box or mallee box); mature and tough older leaves seem to be preferred. The same moth, or possibly a subspecies, also occurs

in the SW. of Western Australia, ranging at least as far north as Geraldton, where it can be abundant. Around Geraldton, they are often conspicuous on *E. camaldulensis* Dehnh. in March and on other eucalypts of the city streets and gardens.

The primary purpose of this paper is to illustrate, with photographs, the bizarre way in which a series of cast larval head capsules are transported about, in the form of a cephalic "horn", by the larvae of *U. lugens* (Figs. 6-10). This retention and transport of cast head capsules is a morphological phenomenon which is maintained automatically with each successive moult, after the 4th or 5th instar, as an end result of the manner in which the prothoracic or cervical portion of the most recently-moulted skin (with its associated hair tuft still intact) remains securely attached to the next (earlier) head capsule above it. This erect or curving column of cast head capsules is in no way tied together or otherwise held in place by means of silk as might at first be suspected. (An observer from the United States might notice the amusing similarity of this tapering stack of head capsules to the caudal appendage of a rattlesnake — *Crotalus* sp.!)

It is hard to imagine what (if any) purpose the retention of a stack of head capsules might serve. Perhaps it might attract the first one or two investigative pecks from a bird or lizard; the predator would initially obtain only a mouthful of dry exuviae. However, the dense, hairy coat alone (consisting of both short, bristle-like and more elongate, softer setae) would probably serve as an adequate repellent for most birds. If a bird really desired to consume one of these larvae, it is unlikely that it would be deterred by a stack of rather easily-dislodged exuviae attached to one end of the morsel.

These stacks of head capsules are sometimes dislodged, altogether or partially, under natural conditions, but I have never observed such "hornless" larvae showing signs of injury or any abnormal behavior. The capsules could be lost accidentally at times -- for example, by being dislodged when a larva crawls through a narrow passage between leaves or twigs, or during strong winds and rainstorms, conditions which can be relatively frequent during winter. Mature larvae, with complete sets of head capsules intact, are often encountered under natural conditions. (Fig. 9 shows a mature larva carrying a complete set, as viewed from the front; it had been feeding at the leaf edge before the photo was taken.)

I have never observed these larvae in the process of moulting. In this particular case, close observation of the moulting procedure could be of some interest. Note how the long anterior setae of the thoracic region sweep forward and upward into (behind) the two most recent capsules, thus stabilizing the whole stack over the head of the living larva (Fig. 6). The degree to which the tip of a complete stack sometimes curves back is shown in Fig. 8; in earlier instars, the head capsule "horn" is relatively

straight and usually somewhat forward-directed, or it can be nearly vertical. The larva in Fig. 7 is depicted in a typical resting position on a stem of *Eucalyptus odorata.*

As a unique signature to this distinctive larval habit, the head capsule stack (or, more often, a part thereof) is usually attached to the outside of the cocoon, positioned centrally (Fig. 10). Some cocoons observed did not have any head capsules attached, but many did. I do not recall ever having seen a cocoon that was decorated with more than 3 or 4 head capsules, although I was not studying this species intensively during my years at Blackwood. These notes are drawn only from one complete rearing, supplemented by various casual field observations. I won't even attempt to speculate on possible "reasons" why these larvae should attach their cast head capsules to their cocoons! If anything, one would think that this might tend to make an otherwise well-camouflaged cocoon somewhat easier for potential enemies to discover.

The construction of one cocoon was observed. I am quoting below from my field notebook (N1.2, in part):

"In a typical nolid cocoon, elongate and spindle-shaped; formed on a stem of the foodplant, from which slivers and particles of epidermis or thin bark are chewed and then woven (from the inside) into the structure, the end result blending nicely into the contour of the stem to which it is attached. The cocoon is started by building up both sides, "boat-like", as the larva chews material off the stem upon which it clings outstretched, and (later) from just to the front and rear of the cocoon limits. Most of the thin bark particles chewed from the stem are fairly long and splinter-like; they are built into the cocoon walls roughly parallel to each other and are horizontally placed. The silk is fairly tough and paper-like; color pale tan in the finished cocoon.....The pupa fits very snugly inside, and great care must be taken not to injure it if attempting to open the cocoon....." (The latter is also a typical nolid phenomenon.)

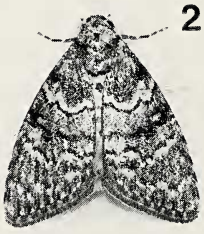
Campbell (1962) states that the majority of cocoons are formed under bark, lower down on the trunks, or in leaf litter on the ground.

The pupa is a rich, medium-brown in color, shading to very dark brown on the dorsum, especially in the thoracic region, with a dark brown line on the dorsomeson. Shell rather soft, with very little surface gloss. Abdominal movement was noted as being "lively, but only within a rather restricted circle, quick and spasmodic, then stopping abruptly."

The lowland-coastal form of this moth is further characterized by its most distinctive mode of oviposition: The eggs are securely-glued (with a nearly colorless adhesive) to the relatively smooth, flat surface of a living eucalypt leaf, in precisely-shaped parallel rows. Fig. 5 (left) shows a close-up of only a few eggs in one oviposition. For a more complete picture of one egg "mass", see McFarland (1972: 229, Fig. 17); a photograph depicts nearly all the eggs in one female's oviposition — in that particular example,

consisting of seven parallel rows, each containing between 17-22 eggs (total of about 135 eggs). Some ovipositions observed contained as many as 8 to 10 parallel rows and more than 180 eggs. A straight row containing 18 eggs in close contact measured 9 mm. in length. A most distinctive (possibly unique) feature of larval emergence from the egg is that no chewing of the shell takes place. Instead, a round and clean-cut preformed operculum or "lid" is pushed off the top of the egg by the emerging larva. Fig. 5 (right) shows two S.E.M. photos depicting empty (hatched) egg shells of *U. lugens,* with opercula ajar. In many cases, the lids fall away altogether after the larvae depart, but sometimes they fall back into the opening or remain balanced a little to one side. This is reminiscent of many hemipterous eggs, but I have never before observed this mode of eclosion in any other species of Macrolepidoptera. Larval silk strands can be seen on some of the eggs. No post-eclosion feeding on the empty egg shells takes place in this species.

The photographs of adults included here (Figs. 1-4) compare well with the *lugens* series in the B.M.N.H.. The adults are strictly nocturnal, coming in abundance to ultraviolet light. There are two generations per year at Blackwood: a spring-early summer brood is on the wing from late Oct.-Dec., and a late summer-autumn brood flies from late Feb.-April.



Figs. 1 & 4: *Uraba lugens* -- Spread ♂ & ♀; LFW. (length of forewing from base to tip, in a straight line) = 11 mm. (♂) & 14 mm. (♀) — (Blackwood, S. AUSTRALIA — April 1968 — uv. light). Figs. 2 & 3: Live ♂♂, in typical resting position; LFW. (both) = 11.5 mm. — (Blackwood — 1 Apr. 68 — uv. light).

The larvae are conspicuous on eucalypts around Blackwood from mid to late summer (Jan. through March), and again from mid winter to early spring (July through mid Oct.). Defoliation, when it occurs, seems to be associated primarily with the spring brood at Blackwood (Sep.-Oct.). They often seem to favor sapling eucalypts, or stunted and struggling smaller trees in poor condition. Incidentally, this apparent preference for unhealthy trees would appear to indicate their importance as "natural thinners". If, at times, they actually killed the weaker trees in a stand of eucalypts, the remaining nearby trees would thereby benefit from reduced competition.

PARASITES: Two species of small hymenopterous parasites, and one hyperparasite, were reared from a series of *U. lugens* larvae (N1.2A) collected on 28 Feb. 1977, along the west side of the Northwest Coastal Highway, about 6 mi. N. of Geraldton, Western Australia, on *Eucalyptus camaldulensis*. The nolid larvae were in about 2nd or 3rd instar when collected. The parasites killed their hosts in about 4th or 5th instar, and attached their cocoons to the foodplant leaves next to the shrivelled host remains. These parasites all emerged in March, 1977, and were code-numbered "H65", and "H67", the latter being the hyperparasite (4 of which emerged from one cocoon of "H65"); no determinations have been obtained for these wasps.

The other purpose of this paper is to draw attention to the fact that, in the Old World at least, this peculiar nolid larval habit of carrying about a stack of cast head capsules is by no means unique to only one genus or species, nor to Australia. In April 1971, while searching through the nolid drawers at the B.M.(N.H.), London, I came across specimens of two EUROPEAN nolids demonstrating precisely the same habit: *Roeselia togatulalis* Hubner (the first species appearing under *Roeselia* in the B.M. systematic collection), and *R. nitida* Hampson. The former was represented by many adult specimens from Germany, and four inflated larvae, one of which had a "cephalic horn" of four head capsules attached (main coll. and drawer 3-39, supplementary series). One of the dry larval specimens is attached to an unidentified, skeletonized leaf of what appears to be one of the deciduous, lobe-leafed oaks (*Quercus* sp.). In the main collection there is also a cocoon having the last instar cervical hair tuft (carrying two head capsules) attached to its outside at about middorsum, and projecting forward from its place of attachment just behind the highest point on the cocoon dorsum, which is at the upper (caudad) end of the emergence-slit. Under *R. nitida* one cocoon, similarly-decorated but with only one head capsule, was encountered (main collection).

Later, Mr. D. J. Carter, of the B.M. Ento. Dept. (in litt. — 1971-72) kindly provided me with a copy of some notes and sketches made in 1891 by "H. C. Harford, Major 2nd Wilt. Reg.", depicting this habit yet again in another nolid from INDIA. The moth involved was thought (by Harford) to

be *Rhynchopalpus argentalis* Moore, but it appears that he was not entirely certain about the determination. Mr. Carter kindly took three color slides of the Harford sketches for me, and from these I was able to obtain two reasonably satisfactory black-and-white prints for inclusion in this paper (Figs. 11-12). The third, an excellent sketch of four larvae feeding on the foodplant leaves, was too pale for black-and-white reproduction. Handwritten notes jotted on the same page (around the three sketches) are interpreted as follows, some words being unclear: "1st spun up 14 May 91 — Out 11 June 91. Larvae sent to me by Major Gaje V Ghurkas(?) from Dharmsala. I also took one of the moths at Dalhousie, in my room. Food plant Ilex Oak. I gave the cocoon and one of the moths to the British Museum." (Mr. Carter has suggested the "Ilex Oak" might be *Quercus ilex* L..) Along the foodplant stem, in the larval sketch, was written the date "10-5-91", which should be interpreted as 10 May 1891 (not Oct. 5th).

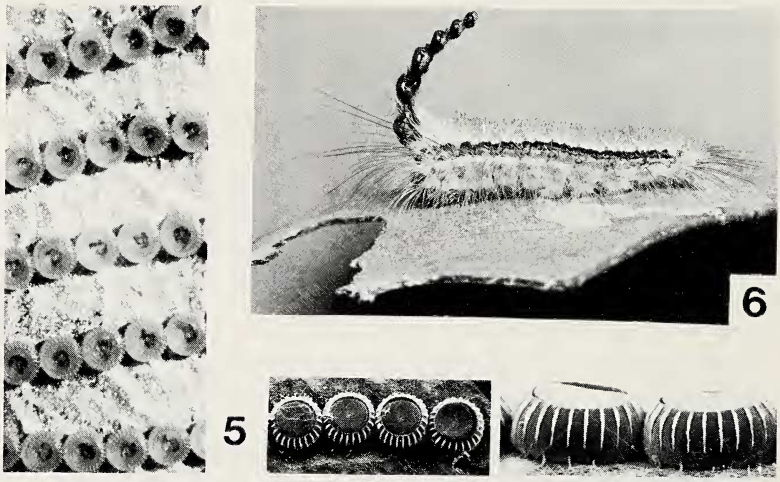


Fig. 5 (left); *Uraba lugens* -- Unhatched living eggs; size = 0.50 X 0.25 mm. — (Blackwood — 1 Apr. 68); Fig. 5 (right): Empty (hatched) egg shells showing opercula ajar (S.E.M. photos). Fig. 6: Live final instar larva at rest on *Eud. odorata* leaf; length = 17 mm. — (Blackwood — 12 March 67); predominant dorsal groundcolor is pale-yellowish (cream ventrally), with hairs mostly whitish-cream.

Notes jotted beside the larval sketch were as follows: "As they appear when feeding.. As a rule they feed very close together. I have drawn them far apart on purpose. Underside of leaf — larvae feeding." Two of these larvae were drawn to show the dorsal surface; they have a profile fairly similar to that depicted in my Fig. 8, but with more pronounced segmentation. The maculation, however, is entirely different. There appears to be a thin middorsal black line, which enlarges into two black spots at the caudal end (A7-A8?), with a larger middorsal spot also on what appears to be A3, and a smaller subdorsal black dot on either side of what appears to be T3. The sketch is lightly watercolored, with the dorsal ground color depicted as pale yellow-cream, and a deeper golden-tan or very pale yellow-orange in the suranal region. The head capsules are shown as jet black, and the hair tufts joining the cast capsules are painted a rich medium-brown. Only two cast capsules are shown attached to each of the four larvae illustrated.

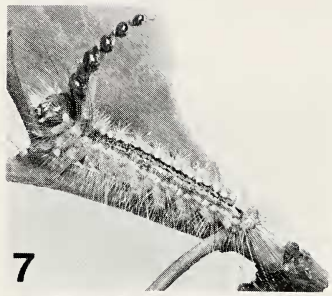
The date faintly written at the lower left of the stem, in the cocoon drawing (my Fig. 11), was interpreted as "23-5-91" (i.e. - May 23rd). Notes jotted beneath the sketch of cast head capsules (my Fig. 12) were quite clear, as follows: "A = Brown silken tuft springing out from behind the head; B = Head and skin of old shed skin."

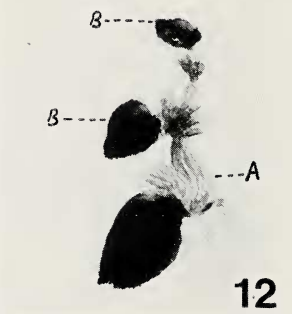
The last example of head capsule retention by a nolid larva known to me, is from JAPAN. The nolid involved is *Memerastria mandschuriana* Oberthur. An adult, and a profusely-hairy larva carrying a cervical stack consisting of several attached head capsules, are both illustrated with good color photographs (Pl. 14, Fig. 35) by Mutuura et al. (1970). The species is also described in pp. 41-42, but I cannot comment further on this as the text is in Japanese. The scientific name of the foodplant is not given.

I have never seen this strange larval habit reported for any New World species, but it would certainly warrant watching for; particularly among the Mexican and Central or South American nolids whose life histories remain unknown.

Acknowledgements, Determinations, and Specimen Distributions: I would like to thank D. J. Carter of the Ento. Dept., B.M.(N.H.), London, for providing the xerox copy and slides of the nolid from India; also D. S. Fletcher, of the same Dept., for his help in sorting out the generic nomenclature associated with *lugens*; Dr. Allan Watson, David T. Goodger, and Maureen A. Lane (all of B.M., London), for providing the two S.E.M. photos used in Fig. 5; M. S. Moulds (Sydney, Aust.) for reviewing the manuscript in 1977 and offering constructive criticisms. Figs. 1-10, with the exception of the two S.E.M. photos in Fig. 5, are from photographs by the author; Figs. 11-12 are prints from color slides kindly provided by Mr. Carter.

All stages of the *U. lugens* life history from Black wood (plus notes) were deposited in the South Australian Museum (Ento. Dept.), Adelaide, under the McFarland code-number "N1.2", and some adults were given to B.M.(N.H.); Geraldton specimens, and associated parasites, were deposited in the Dept. of Agriculture (Ento. Section), South Perth, under "N1.2A".





Figs. 7-9: *Uraba lugens* -- Live final instar larvae (same data as for Fig. 6). Fig. 10: *Uraba lugens* -- Recently-formed cocoon with 3 attached head capsules; length = ± 22 mm. (Blackwood — late Mar. 67). Figs. 11 & 12: (?)*Rhynchopalpus argentalis*, cocoon and larval head caps., from sketches by H. C. Harford (Dharmsala, INDIA — May, 1891).

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